LOOM STTR
Final Report

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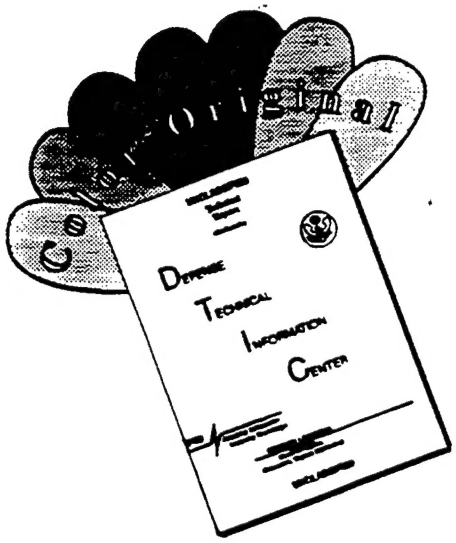

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Per Carl Friedlands 3/4/97
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A Business Plan for

PowerLOOM and the STELLA Product

Submitted By

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1. Executive Summary

This STTR is a first step in identifying the opportunities that may exist for one of the principal products of a DARPA funded research and development effort, the PowerLOOM system and the STELLA language. In this effort, a knowledge system, PowerLOOM, has been developed using STELLA. The current state of that environment and its preparation for distribution places ISX and USC/ISI in an environment from which this fledgling system may be converted from a simple research environment into a potentially distributable and marketable status. Our experience and participation in the distribution of the LOOM system helps to prepare us for this cooperative effort. The work in this effort is a cooperative effort of individuals at both the USC/ISI organization in Marina Del Ray, California and individuals at the ISX corporation in Westlake Village, California. In particular, the two leadership individuals who have produced the majority of this document are Robert MacGreggor Ph. D. of USC/ISI and Carl Friedlander Ph. D. of ISX.

Products

The total number of PowerLOOM components are relatively limited in number, and scope. This knowledge base management system provides for an integrated process as part of an advanced software system. The major products of the PowerLOOM development will be those of the STELLA language system, the user interface component, and the main knowledge base manager which includes both a shared ontology and the classifier, production rules backchainer and constraint system. We believe that this is a most appropriate starting point for the development activity of this STTR. Over time, additional quality and hardening of the currently public interface components may become part of the complete product set.

Market Analysis

Our initial market study demonstrates that there exists a sufficiently large market need for a well structured knowledge base process and for an infrastructure that will support the full interaction of the various components that make up the PowerLOOM environment. Increasingly, organizations are developing software components that development of systems that can easily be built in the STELLA environment. STELLA provides a unique opportunity to structure and organize the requirements of these systems.

Marketing Strategy

Our current expectation is that the most attractive areas into which we expect to be able to sell the STELLA products of our effort will be in the fields of Engineering and Manufacturing, Research and Education, or Systems Integration. Though other organizations may be interested in using the products that are likely to be developed as part of the work that we do. It is less likely that they will lead to the development of products that are in high demand. Our strategy is to enter the marketplace by demonstrating the system and delivering the major infrastructure components for free. After a Beta period, we will sell the major components and the STELLA components of the technology.

Financial Projections

Initial financial projections Indicate that the overall market is in the size range of hundreds of millions of dollars. This size projection is based on the number of applications that are developed in the engineering and manufacturing companies, systems integration companies, transportation companies and research and education companies that are in existence today. Each of these organizations is a consumer of the systems that we care constructing and planning as a system for fielding. Examining the current costs for these organizations and anticipating their future growth necessities leads us to believe that the marketplace will grow from $200 million to $800 million over a period of 5 years.

2. Product Description

Background

The LOOM product provides significant utility when presented in its independent LISP language environment. The PowerLOOM product provides a similar, if not equivalent, facility that extends beyond the LISP language to the more commonly acceptable and accessible C++ language.

The LOOM Project is an effort of the Artificial Intelligence Research Group at USC's Information Sciences Institute. LOOM is a language and environment for constructing intelligent applications. The heart of LOOM is a knowledge representation system that is used to provide deductive support for the declarative portion of the LOOM language. Declarative knowledge in LOOM consists of definitions, rules, facts, and default rules. A deductive engine called a classifier utilizes forward-chaining, semantic unification and object-oriented truth maintenance technologies in order to compile the declarative knowledge into a network designed to efficiently support on-line deductive query processing.

The LOOM system implements a logic-based pattern matcher that drives a production rule facility and a pattern-directed method dispatching facility that supports the definition of object-oriented methods. The high degree of integration between LOOM's declarative and procedural components permits programmers to utilize logic programming, production rule, and object-oriented programming paradigms in a single application. LOOM can also be used as a deductive layer that overlays an ordinary CLOS network. In this mode, users can obtain many of the benefits of using LOOM without impacting the function or performance of their CLOS-based applications.

LOOM has been distributed to more than 80 universities and corporations, and is being used in numerous DARPA-sponsored projects in planning, software engineering and intelligent integration of information.

LOOM Projects

LOOM is being applied in the domain of computer image understanding in the VEIL project, an experiment that links a LOOM-based domain model with geometric objects produced by an image understanding program. The use of a LOOM superstructure enables interaction with the image system at a higher-level of abstraction--discourse is at the level of domain concepts such as buildings and headquarters rather than pixels or cubes.

We are also working on a successor system to LOOM, tentatively known as PowerLOOM. PowerLOOM will have a more expressive language than

LOOM, classifying descriptions expressed in full first order predicate calculus. It will also be available in both Lisp and C++ versions. PowerLOOM is built in the language STELLA supporting a straight forward development environment.

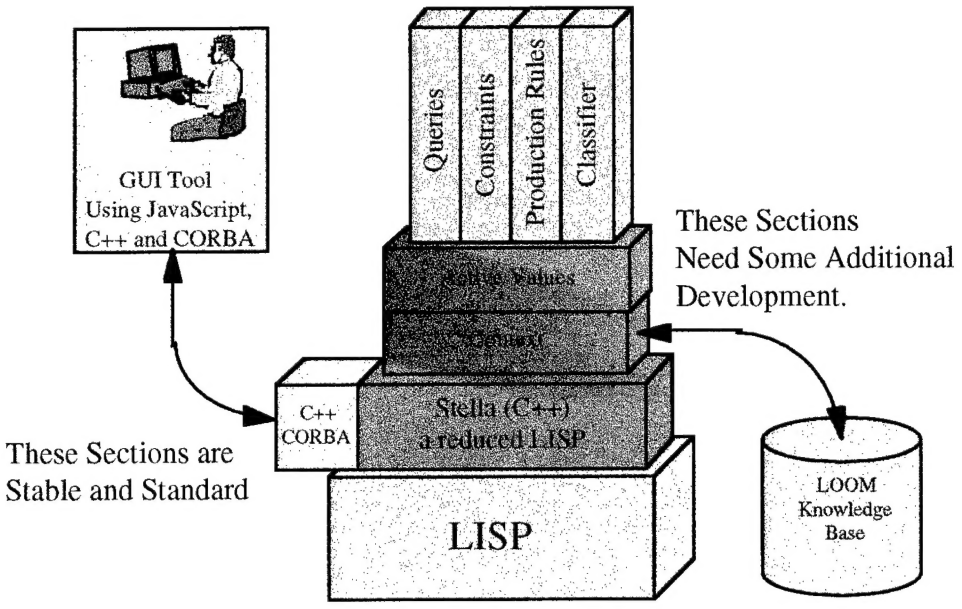

Figure 1.
The PowerLOOM and STELLA environment.

In figure 1, we present the integration of the PowerLOOM and STELLA components. PowerLOOM contents are all written out of the LOOM system and take advantage of the facilities provided in the STELLA language. STELLA allows implementation of the LISP facilities in a new and unique software organization. To improve the user's facility to utilize the underlying information system, we have takes advantage of C++ and CORBA facilities.

STELLA -- Painless Symbolic Processing in C++

Common Lisp provides a very supportive environment for the development of symbolic processing applications (e.g., "intelligent" applications). However, Common Lisp has several drawbacks: Its performance is slow (as compared to a C++ program); it does not interface well to tools and applications in commercial environments (e.g., to C++ and CORBA); and it fails to incorporate recent object system trends (e.g., collections, iterates, and parameterized types). As a result, customer demand and vendor support for Lisp is declining, creating yet another reason to abandon Lisp.

Developers of intelligent applications face a problem, since none of the currently "healthy" languages such as C++ provide adequate environments for the construction of symbolic processing programs. Our response has been

to invent a new programming language, called STELLA, that incorporates aspects of Common Lisp that we deemed essential into a language that can be translated into efficient, readable C++ code. STELLA resembles a simplified version of Lisp, extended to include strong typing and a modern object system. Our translators can compile a STELLA program into either C++ or Common Lisp code. We have benchmarked our translators on the STELLA system itself. Our results show that the C++ version of STELLA compiled with g++ executes about 10 times faster than the equivalent Common Lisp (CLOS) version compiled with Allegro CL 4.2. This list of results provides a contrast to systems like Kyoto Common Lisp or Chestnut. Those systems support C-based outputs usually executing slower than native Common Lisps. The C-based Lisps are handicapped from a performance standpoint because they use C as an intermediate language to implement the full functionality of Common Lisp.

To date, we have programmed approximately 28,000 lines of STELLA code, 22,000 lines (890K) of STELLA kernel code, plus 6,000 lines (255K) of STELLA (knowledge representation system) code. Our subjective experience indicates that it is only slightly more difficult to write and debug a STELLA program than a Lisp program. We use the Common Lisp-based version of STELLA for prototyping. Thus, we appear to have achieved our goal of combining the rapid-prototyping capabilities of Lisp with the efficiency of C++.

A new approach to software engineering, that of agent-based software engineering is producing technology that provides a step toward a solution to the interpretation problem. In this approach, a system is built from a collection of software agents, programs that communicate with other agents by exchanging messages. The inner workings of the programs are *encapsulated* or hidden, with only their interfaces exposed to other agents.

Like a collection of people in an organization, each agent provides services to other agents and requests services from other agents. Services consist of providing information of various kinds, e.g., the truth value of a statement, all information available on a specified topic, and inferences that can be made from a given fact. Requests for services and the products of services rendered are communicated through messages which, if interoperability is to be achieved, must be represented in a common language. Language commonality requires the use of communication language standards. If programs follow these standards, they can communicate, no matter how great the differences in the details of their implementation, which are hidden by encapsulation.

Development Plans

We are aware of no plans for development of a STELLA product other than that which can be built by ISI and ISX. A detailed development plan may be

developed as a Phase II proposal. In summary, a two year project will be proposed beginning in 1997. It is expected that a Phase II effort would produce a Beta system in late 1998 or sooner. Following a six-month Beta Test, a commercial product would be available for release in early or mid 1998.

3. Market Analysis

Market Overview

Although STELLA is being developed for improved LOOM system development environments. Developers of intelligent applications face a problem, since none of the currently "healthy" languages such as C++ provide adequate environments for the construction of symbolic processing programs. Our response has been to invent a new programming language, called STELLA, that incorporates aspects of Common Lisp that we deemed essential into a language that can be translated into efficient, readable C++ code. STELLA resembles a simplified version of Lisp, extended to include strong typing and a modern object system. Our translators can compile a STELLA program into either C++ or Common Lisp code. We have benchmarked our translators on the STELLA system itself. Our results show that the C++ version of STELLA compiled with g++ executes about 10 times faster than the equivalent Common Lisp (CLOS) version compiled with Allegro CL 4.2. This list of results provides a contrast to systems like Kyoto Common Lisp or Chestnut. Those systems support C-based outputs usually executing slower than native Common Lisps. The C-based Lisps are handicapped from a performance standpoint because they use C as an intermediate language to implement the full functionality of Common Lisp. Our competitive analysis (see Section 4) suggests that this competitive development will not happen.

Market Segmentation

There are at least four major categories of applications requiring software interoperation:

- Concurrent engineering is the process of developing systems that operate in a simultaneous or parallel manner.
- Database integration is the process of collecting and integrating information from multiple sources and then operating on that information in parallel.
- Collaborative design systems are those systems used to support planning and development in a collaborative way for groups of people working in unison on a group design.
- Distributed transportation planning and scheduling uses integrated information from a number of executing resources.

These application categories lead to identification of four major STELLA market segments: engineering/manufacturing, system integration, and transportation, and research/education.

Engineering and Manufacturing

STELLA will be used in producing large-scale distributed systems for engineering/manufacturing firms. Applications include concurrent engineering, database integration, and collaborative design. Major customers will be found in the aerospace industry and among automobile and computer/electronics manufacturers.

Systems Integrators

System integrators will use STELLA to build concurrent engineering and database integration applications for clients and for their own companies. Customers will be consulting companies and MIS/Information Integration departments within major manufacturers in the computer/electronics, automotive, aerospace, and transportation industries.

Transportation

In addition to information integration applications, customers in the transportation industry will use STELLA to build distributed transportation planning and scheduling applications. Customers will be found primarily in trucking and warehousing, air, and rail transport companies. Customers may also be found among shipping companies, but the longer planning horizons for water transportation limits the benefits of large-scale planning and scheduling systems.

Research and Education

STELLA is being developed by researchers interested in agent-based architectures research using applications such as concurrent engineering, database integration, collaboration, and transportation planning and scheduling. A STELLA product will support continued research in this area.

A natural extension of research on agent-based architectures is the use of agent technology as a topic in computer science curricula. The major application would be advanced university computer science laboratory courses.

Market Size

Engineering and Manufacturing

There are approximately 3,000 large engineering/manufacturing firms in the U. S. today, each spending approximately $100 million annually on information technology. If it is assumed that 10% of a firm's information technology budget is allocated to development of distributed systems, the distributed systems market today is $30 billion; by 2000 it will be more than $58 billion. Purchases of a mature PowerLOOM and/or STELLA product or other communications technology supporting interoperability may account for .5% of the total distributed systems budget -- almost $300 million in the year 2000.

Systems Integrators

The integrated information systems service sector is huge and growing rapidly. In 1992, sales of the top ten service companies in this segment were $13.8 billion. In California alone, 202 firms are listed as computer systems integrators. Virtually every major computer manufacturer or consulting company has made a sizable commitment to information integration. These providers of integration services are potential customers for tools and software components employing STELLA and PowerLOOM. Total sales for this segment is estimated to be $19 billion today, with growth to over $25 billion by 2000. Assuming that 10% of sales is spent on information technology each year and 10% of the information technology budget is spent on interoperability communications technology, the market for a STELLA and/or PowerLOOM product in 2000 will be $250 million.

Transportation

The transportation sector accounts for approximately 4% of Gross Domestic Product, with approximately $190 billion in sales estimated for 1994. Trucking and warehousing accounts for over 40% of the total, and rail and air each account for about 20%. Assuming that 3% of sales is spent on information technology and .5% of the information technology budget is spent on interoperability communications software, the PowerLOOM and/or STELLA market in this segment will be $300 million in 2000.

Research and Education

There are estimated to be approximately 300 university laboratories, 300 industry laboratories, and 50 government laboratories with research programs and the resources that would qualify them as PowerLOOM and/or STELLA

customers. This number is not expected to increase significantly over the next ten years. Detailed data on market potential is unavailable, but if it is assumed that 10% of the estimated 650 potential research customers purchase PowerLOOM and/or STELLA in the first five years of product availability (30 university labs, 30 industry laboratories, and 5 government labs), and each customer purchases a license for five development seats, then it is estimated that 325 copies of a PowerLOOM and/or STELLA product will be sold over five years for use in research applications.

There are approximately 750 research universities and 600 "other" universities with a computer science program. It is assumed that over the first five years of product availability, 10% of these institutions (75 research universities and 60 "other" universities) will buy PowerLOOM and/or STELLA for instructional purposes. If universities buy an average of 5 development seats, 625 copies of a PowerLOOM and/or STELLA product will be sold over the first five years for instructional use.

4. Marketing Strategy

The PowerLOOM and/or STELLA marketing strategy should be to:

1. initially focus on the research and education markets, the markets with the greatest potential for sales in the near-term, while

2. laying the groundwork to move into the commercial markets by

   a. winning government contracts (beginning with a Phase II STTR) that support the development of the robust PowerLOOM and/or STELLA product required by commercial customers, and

   b. forming a strategic alliance with a larger company in order to fill its weakness in manufacturing, marketing, sales, and support.

All activities should be directed at positioning STELLA as providing communications capabilities in support of CORBA-compliant and other distributed system development products.

Near-Term Strategy

Research and Education

In the near-term, the primary market is research applications in university, industrial, and government labs. The STELLA implementation produced by the Phase I STTR is adequate for success in this market, but work must begin to increase reliability, probably by doing minor redesign and extended World Wide Web development, delivery and exposure. In addition, documentation must be improved and procedures for customer support must be established. ISX should contact potential customers through a direct mail campaign to all university, industrial, and government laboratories in this country, Europe, and Japan.

Marketing to research laboratories should be extended to the educational market, focusing on university computer science instructors. In addition to taking steps to improve reliability, success in this market may require preparation of courseware, including workbooks and preprogrammed examples tailored to the workbook exercises. To enter this market, ISX should advertise through telemarketing and a direct mail campaign to university and junior college computer science departments. Advertisements in trade journals should also be used. ISX should also consider developing a strategic alliance with a textbook publisher that successfully markets and services computer science departments. Our current relationship with Zaner-Bloser is probably not appropriate for computer

science curriculum, but may help in establishing contacts with other publishers.

Custom Application Contracts

Custom application contracts with NASA, DoD, and commercial companies should be used to develop new PowerLOOM and robust STELLA functionality. The NASA SOFIA and CFD Advisor projects are good candidates, as are anticipated DARPA education, intelligence projects, and ACPT follow-on projects.

Long-Term Strategy

Commercial Applications

Commercial applications in engineering/manufacturing, systems integration, and transportation industries are the most promising markets available to both PowerLOOM and STELLA products, but important groundwork must be completed before ISI and ISX can be successful. The use of custom application contracts to develop robust PowerLOOM and STELLA functionality is a requirement for entry into these markets. A second is to correct the company's weakness in manufacturing, marketing, sales, and support by establishing a strategic alliance with a large company that has these capabilities. This alliance could be used to help ISX get the capital it needs to develop future products, too. There is a danger, of course, in losing control of the company to the partner, but there is no alternative to establishing an alliance other than obtaining money from a venture firm, which is probably more dangerous, or finding private investors, which may also be dangerous and is probably much more difficult. Aside from getting enough near-term contract revenue to keep a PowerLOOM and/or STELLA business going, establishing an advantageous strategic relationship should be the most important objective of PowerLOOM and STELLA product management.

Next Steps

Based on the strategic plan, decisions that must be made now include:

- The requirements for design of a STELLA product that will complement anticipated CORBA-compliant product functionality.
- The requirements for documentation and support.
- Identification of targets for telemarketing and direct mail.

- Identification of appropriate trade journals for ads.

- The requirements for courseware supporting educational applications of PowerLOOM and/or STELLA.

- The marketing focus and detailed marketing plan for near-term custom application contracts.

- The plan for using custom application contracts to develop new products.

- Identification of potential strategic alliance partners.

The information needed to make these decisions includes:

- Definition of anticipated CORBA-compliant product functionality and complementary functionality to be supplied by PowerLOOM and STELLA.

- Definition of customers, customer applications, anticipated uses of documentation, and anticipated support needs.

- A list of potential customers, with contact names, addresses, and telephone numbers, among university, industrial, and government laboratories, and university and college computer science departments.

- A list of candidate trade journals for ads, with information on the cost of ads and circulation statistics.

- For educational applications, definition of students, instructors, educational applications of PowerLOOM and STELLA, and anticipated uses of courseware.

- A review of the current status and outlook of marketing on custom application contracts.

- A list of potential strategic alliance partners, with contact names, addresses, and telephone numbers, and any information available on the advantages and disadvantages of dealing with each as a partner.

5. Advertising & Promotion

To achieve its sales goals, we must immediately begin an aggressive campaign of direct mail to university computer science laboratories and departments, industrial laboratories, and government laboratories. In addition, a comprehensive advertising and promotion plan should be developed for both PowerLOOM and STELLA. That advertising and promotion plan would include plans for trade journal advertisements and display booths at major industry conferences.

Advertising & Promotion Objectives

Position PowerLOOM and STELLA as the only products that offer low cost, efficient, and reliable communications functionality in support of large-scale distributed system development.

Increase awareness of PowerLOOM and STELLA among university, industrial, and government computer science researchers, university and college computer science educators, and government/industry customers for custom applications.

Generate qualified sales leads for research, educational, and custom applications.

Coordinate sales literature, demonstration materials, and direct mail promotions in order to focus all advertising/promotion on the target markets.

Advertising Campaign

The best way to reach our potential customers is to develop an advertising campaign promoting our theme — "PowerLOOM: Providing a Communications Infrastructure for Distributed Systems ."

To establish PowerLOOM or STELLA's image, the advertisements will show the excitement and glamour of a leading edge technology while emphasizing the affordability.

To eliminate the biggest objections to immediate action, our advertisements must remind the audience that PowerLOOM and STELLA are based on technology developed leading researchers under DARPA finding and that they are now available in usable, affordable form with access through the world wide web over the internet.

Promotion

In addition to print advertising, we will gain considerable recognition through product booths at trade shows and press releases describing applications of PowerLOOM and STELLA. We will also plan on extensive distribution through the World Wide Web display throughout the Internet.

Product Brochure

Objective

Portray PowerLOOM and STELLA as the leading supplier of low-cost software component applications as demonstrated by software developers at University of Southern California, Information Sciences Institute.

Recommended Contents

Introduction/Background

- Distinguish PowerLOOM and STELLA from competitor's products
- Statement of business philosophy
- Description of the technology and a list of "firsts" and "one times"

Product Profile

- History: formed by nationally recognized researchers and applies of advanced technology to real problems
- Capability: give an overview of the product
- Product Development: describe continuing, leading edge product development activities
- Support: describe quality control and support policies

How to Get More Information

- Names, addresses and telephone numbers

6. Financial Projections

Information required for development of business plan financial projections such as an Income Statement, Cash Flow Forecast, Balance Sheet, Break-Even Analysis are not available. Revenue projections based on the sales forecasts developed in this business plan are presented in this section. The following table provides a template for developing a forecast by market segment for an assumed unit price. We currently do not have enough information to accurately predict the appropriate market price or unit price. We will certainly reach that point in the not to distant future.

Estimated STELLA Revenue, 1997 - 2001
Unit Price = $tbd

Market	1997	1998	1999	2000	2001	Total Units	Revenue ($K)
Research						tbd	tbd
Education						tbd	tbd
Eng/Mfg						tbd	tbd
Syst. Integ.						tbd	tbd
Transport.						tbd	tbd
Total						tbd	
Revenue ($K)	tbd	tbd	tbd	tbd	tbd		$tbd